COURTESY JOE ROBSON

Classic coating: varnish from the rib of a Francesco Stradivari violin of c.1732

SHINING EXAMPLE

A close look into the history and chemistry of varnish making can shed new light on the mysteries of classic Cremonese varnish, as JOE ROBSON explains

There is a genuine, well-deserved mystery surrounding the making of a violin. The combination of materials, from the wood to the strings, fittings and varnish, as well as the interaction of the luthier with these materials, is – to say the least – complex. Likewise, there is a great deal of mystery surrounding violin varnish itself. Classic Cremonese varnish in particular has a warmth of colour, a liveliness of reflection, a clarity and a longevity which have made it the pinnacle of violin coatings. Yet whether or not we ever unlock the secrets of the great Cremonese violin varnish, there should be no mystery about varnish itself, its uses and its origins.

Varnish is simply tree sap and vegetable oil cooked together. Yet violin varnish displays true synergy in its materials. Its ingredients are brought together in a particular way that creates an entirely new substance, and one that is different from its ingredients in ways that could not be predicted by the ingredients' own individual characteristics. The index of refraction of a well-made varnish, for example, which measures how fast light travels through it,

RAY TANG/REX FEATURES

The oldest varnish can be found on 2,500-year-old Egyptian mummy cases

will be higher than that of any of its constituent parts. Each ingredient brings some of its own distinctive traits to the mix but also loses others. Furthermore, when one component is changed, all of the other ingredients react in new ways. The ways in which raw materials interact in a finished varnish is determined by the varnish maker, and adjusted according to the qualities desired in the final varnish.

Good varnish is not just a fortunate mistake: it is the result of experience and expertise.

Flax seeds are pressed to produce linseed oil, one of the most important ingredients in varnish

As far as we know, the oldest varnish that still exists can be found on wooden mummy cases from Egyptian tombs that are more than 2,500 years old. This ancient varnish, made with five or six parts oil to one part resin, and without a cooked-in solvent, would have been warmed and then applied to the cases with a spatula. Because the tombs offered it protection from exposure, the varnish still looks good today.

The earliest complete description of the varnish making process can be found in the eleventh-century *Schedula diversarum artium* by Theophilus Presbyter, a monk from either Switzerland or Germany. This manuscript explains the combination of linseed oil and heated resin needed to make a durable and beautiful coating for wood, outlining much the same process that was followed before Presbyter's writings. The process that varnish makers follow today has not fundamentally changed since then.

The first ingredient used in violin varnish is vegetable oil, usually walnut or linseed oil. Walnut oil is pressed from the raw nuts and then filtered to prepare it for varnish making. Linseed oil is pressed from the seeds of the brown flax plant, which is also the source of the fibre used in making linen. Flax is an ancient ingredient: it is known to have been used since 7,000BC — remnants of flax linen have been found in Stone Age Swiss lake villages, and it was used in ancient Egypt to weave material for boat sails and to wrap mummies. In making violin varnish, linseed oil must be washed and filtered, then heated to remove any dissolved organic material. Once this process is complete, the oil is ready to be cooked for the final varnish.

Linseed oil has a special quality that makes it particularly useful as a raw ingredient in varnish. If a thin film of soy or olive oil is spread on a piece of glass and exposed to light and warm air, it does not seem to change much. After a few days, the surface simply remains greasy. If a thin film of linseed oil is spread on a glass plate, however, within a few days a remarkable transformation takes place. The residue changes from a greasy liquid into a tough, leathery solid called linoxyn. The drying of varnish thus depends on the linseed oil constituent turning from a liquid to a solid as it is exposed to air and warmth. Linseed oil also gives the varnish film flexibility, an important quality since it allows the varnish to move with the wood as it expands and contracts. ▹

Amber, the fossilised tree sap from forests that grew 30–90 million years ago, from which the resin component in varnish can come

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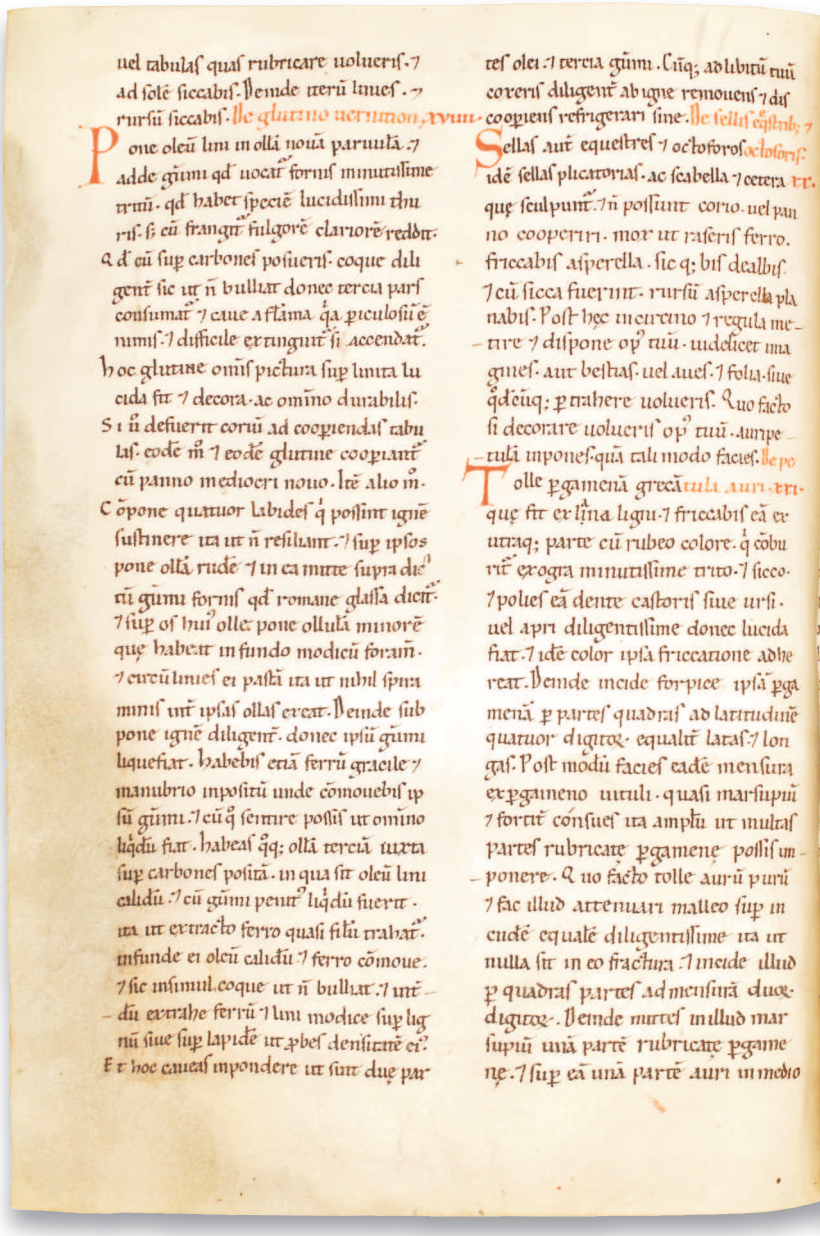

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The second component of varnish is resin. Resins are simply the solids found in tree sap. There are four resins that have historically been used to make violin varnish: amber, mastic, sandarac and pine resin. Amber is the fossilised sap from ancient pine forests that grew 30–90 million years ago. It is mined or collected mainly around the Baltic Sea but has also been found in China, Central America and the US. Mastic is crystallised sap harvested from an evergreen shrub that grows throughout the Mediterranean region, and sandarac is the sap from a small conifer native to the Atlas Mountains of North Africa. Both these resins also have an ancient history of medicinal use: mastic was used as a cure for stomach complaints throughout the Mediterranean, and sandarac was an old Arab remedy for diarrhoea.

ISTOCKPHOTO

The flax plant is known to have been used by man since 7,000BC

The last resin used in violin varnish, pine resin, is collected from a variety of pine species, including the Aleppo Pine, which is also the source of Greek pitch or rosin. Many of the oldest recipes for violin varnish refer to Greek pitch as an ingredient: in his *Classic Italian Violin Varnish* (1985), Geary Baese quotes the 16th-century Venetian Marciana Manuscript's description of preparing a 'lustrous and beautiful' varnish: 'Take for one measure: one pound of linseed oil, and make it boil in a clean glazed pot. Add half a pound of pulverised clear and beautiful Greek pitch, stirring it in, incorporating it well on a gentle fire. Put in half a pound of powdered mastic.'

Amber, mastic, sandarac and pine resin: each of these four different resins must be treated in a different way in the preparation of the final varnish. Sandarac and mastic can simply be dissolved raw in the linseed oil as it is heated. Amber, however, must be pre-cooked at temperatures of over 300°C in order for it to become soluble in the oil. How long and at what temperature the amber is cooked will determine the hardness, brightness and depth of colour of the final varnish film. Pine resin can simply be introduced raw to the varnish mixture, or it can also be pre-prepared by heating in order to separate the solids from the liquid components. This heating procedure produces rosin as a crystalline solid and turpentine as the liquid part of the pine sap. This turpentine is the third ingredient in the making of varnish.

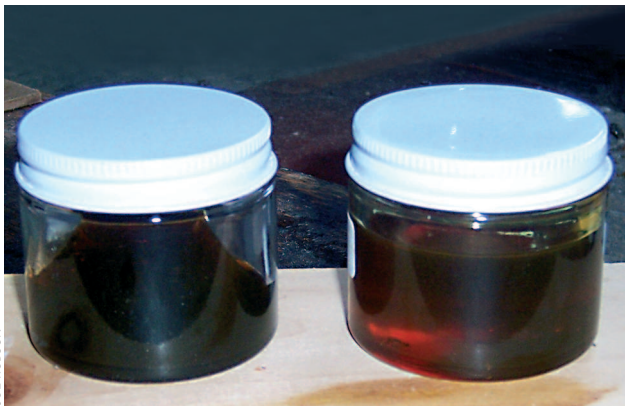
Turpentine can be introduced into the varnish mix in several ways. As already mentioned, it may come from the fractional distillation of raw pine resin into turpentine and rosin, with the turpentine then introduced into the cooking of the varnish. It may come simply from undistilled raw pine sap used in the cooking of the varnish. In this case, since the amount and boiling point of the solvent portion of pine sap differs from species to species, the varnish maker can control the properties of the final varnish by choosing their species carefully. Finally, an alternative natural raw sap such as Venice turpentine, sap tapped from larch trees, may be used in the mix.

Turpentine acts as a solvent and aids the finished varnish's drying properties. Yet the role of turpentine in the making of violin varnish is the least understood and the most discussed aspect of the whole varnish making process. Some historians and violin makers believe that no turpentine was used in the making of varnish during the early and classic periods of violin making. Others, however, believe that this remains an open question.

JOE ROBSON

A complete kit of ingredients for use in the varnish making process, from Joe Robson's workshop

The solvent power of turpentine appears in the historical record as early as 460BC: the Greek historian Herodotus, travelling in Egypt at that time, described the use of 'oil of cedar' in the embalming process. It was later referred to by Pliny the Elder in his *Historia naturalis* of 77AD. Distillation of spirits was developed ▸



JOE ROBSON

Changing ingredients or processes can produce two very different varnishes

Linseed oil, resin and turpentine may be treated in different ways and thereby produce different outcomes in the finished varnish film

by Muslim chemists in the eighth century in what is now Iraq, and spread to Europe with the Arab invasions. During the Middle Ages the oleoresins (resins that also contain essential oils) of Europe were distilled, although in a very crude way. One of the early methods was to put raw pine resin in a clay pot and lay some sticks supporting a wool fleece over the pot. As the pot and resin were heated, the essential oil condensed on the wool, which was then rung out and filtered, and the turpentine collected. In the British colonies in America in the early 18th century, the distillation of pine resin was a considerable industry: pine tar was used to waterproof the ships of the Royal Navy and also merchant vessels.

We do also have some insight into the use of turpentine in 18th-century Italian violin making. Some time between 1739 and 1750 an Italian varnish maker named Alberti published a formula that specifically refers to turpentine as a component of amber varnish, along with linseed oil and litharge (lead oxide). This was probably not an idea that simply sprang fully formed from Alberti's mind one morning. It's more likely that he revealed something that varnish makers had been using for some time: he can't have made any friends in the trade by publishing this method.

In addition to contributing to the fluidity and to the drying properties of the finished varnish, turpentine is essential in the varnish's film-forming capability. The preparation of a varnish that can be applied in a relatively thin, even film depends on the use of the solvent portion of pine resin. Such varnishes generally have a ratio of resin to oil of between two parts resin to one part linseed oil and one part resin to two parts linseed oil. These proportions can be found as early as 1440, when Jacobus de Thaleta described a varnish made with two parts gum of juniper (a raw pine resin) and one part linseed oil. Varnishes of these proportions allow the dry film to be polished to a high degree of sheen. Using more oil than this in the varnish produces a film that dries very slowly, thereby attracting a large amount of dust and other airborne contaminants, and one which does not respond well to surface polishing.

Linseed oil, resin and turpentine, then, are the basic tools of the violin varnish maker. The natural properties of these materials and the relative effect that they have on one another have remained the same from the Middle Ages through to the present day. Each of the ingredients may be treated in different ways and thereby produce different outcomes in the finished varnish film. Linseed oil may be cooked, exposed to the sun, bleached, or altered with chemicals, metals or pigments. Resin — whether fossilised for 40 million years or collected in the forest last week — may be used raw, extensively cooked, or somewhere in between. Turpentine may be introduced into the varnish-cooking process in a variety of amounts and at a range of different temperatures. In fact, the quality of the final varnish can be varied more by the manipulation of the turpentine component than by the manipulation of either the resin or the oil.

The materials may be minimally cooked to a temperature that allows them to combine, or held at a high cooking temperature for many hours. Using pine resin, sandarac or mastic with linseed oil, and cooking them in a traditional manner, a varnish maker might make a very hard, almost colourless varnish that is suitable for furniture. Or, by using a different preparation and cooking technique, the result could be a deep reddish-brown viscous violin varnish.

I have experimented with traditional recipes for varnish cooked with and without turpentine or its natural equivalent for the past 15 years, and I have never been able to make a varnish cooked without pine terpenes (the major constituent of turpentine) which would develop the characteristic surface crackling that can be observed on so many classic instruments. A prime example is the varnish, in a relatively undisturbed spot, on the rib of a Francesco Stradivari violin of c.1732 (pictured on page 60). As we unravel the story of the re-creation of Cremonese varnish, it is certain that any re-creation of this varnish should exhibit the tendency to crackle in this characteristic way as it ages.

The Hills documented that Antonio Stradivari made 1,116 instruments in his lifetime. Even accounting for spillages and mistakes, it is likely that he needed less than 20 gallons of varnish for these instruments. This quantity of varnish may be only a month's work for a good varnish maker. Furthermore, the person that made Stradivari's varnish clearly had a wealth of experience: the qualities of the varnish are far too consistent, and far too sophisticated, to have been unintentional.

Whether the famous Cremonese varnishes were made by the violin makers themselves or by a local alchemist, they were made with intent by a highly sophisticated workman. Both the history and the experience of varnish making both lead us to this conclusion. Whether or not the secrets of the great Cremonese violin varnish are ever fully unlocked, we have the tools at our disposal to examine them closely, and they should not remain a mystery. ■